5/16/13

Note to File
From Leslye Werner

Documents downloaded from MDNR Bridgeton Sanitary Landfill Website
Included

Odors and Air Sampling pages 1-4
Air Sampling Location Map using AreaRAE – Feb 2
Air Sampling Report using AreaRAE – Feb 2
Air Sampling Location Map using SUMMA – Feb 4-5
Air Sampling Location Map using VIPRE – Feb 13
Air Sampling Location Map – Aug 16-17, 2012
Air Sampling Report – Aug 16-17, 2012 – Executive Summary
Sec 5 0 pages 8-15
Table 2

Jay Nixon, Governor
Sara Parker Pauley, Director

Solid Waste Management Program

Odors and Air Sampling - Bridgeton Sanitary Landfill

Home | Site Background | Construction Schedule | Odors and Air Sampling | Subsurface Smoldering Event | West Lake Landfill | Overview

Odors

Odors surrounding the Bridgeton Landfill are attributable to the subsurface smoldering event or corrective actions to address the subsurface smoldering event:

- Increased landfill gas generated from the subsurface smoldering event.
- Construction activities performed to address the subsurface smoldering event and long-term odor control.
- In mid-January, the facility experienced a break in a leachate line resulting in a 1 1/2 week period with heightened odors.
- In mid-February, during drilling of a gas extraction well odors unexpectedly intensified over several hours.

To address the odor issue, Bridgeton/Republic developed a nine-week plan. During these nine weeks, from approximately the end of February through the beginning of May, residents and businesses in the area surrounding Bridgeton will likely notice periodic spikes in odors as these construction activities occur.

In addition to tracking odor concerns, the Department of Natural Resources' Solid Waste Management Program and the St. Louis Regional Office are conducting odor surveillance inspections to evaluate the odor situation at the facility. At this time, Solid Waste Management Program and the St. Louis Regional Office staff will not be investigating each individual complaint as received. Each complaint will be read to determine whether immediate investigation is warranted. The Solid Waste Management Program will be logging and mapping complaints received.

How do I submit odor concerns?
To file a complaint, please complete our online environmental concern form.

Additionally, you may notify the Solid Waste Management Program in any of the following ways to file an odor concern:

- Phone - 800-361-4827 or 573-751-5401 and state you need to file a Bridgeton Landfill odor concern. These phone numbers are available Monday-Friday from 8 a.m.to 5 p.m.
- Fax - 573-526-3902 Attn. Bridgeton Landfill odor concern.
- Email - swmp@dnr.mo.gov.

Note: In case of an emergency, you should contact your local fire protection district using the 911 system.

Department of Natural Resources Air Sampling

On Feb. 1, 2013, the Missouri Department of Natural Resources issued an Order to Republic, which owns Bridgeton, stating the department would immediately begin collecting air sampling data at the landfill. The Order also instructed the company to pay for costs associated with this data collection and to provide the department access to the facility property for data collection operations. Read more.

On Saturday, Feb. 2, 2013, the department employed air sampling equipment at six locations around Bridgeton Sanitary Landfill to assess the current air quality. Continuous air sampling was conducted from early morning to late evening using an AreaRAE system. This system is equipped with a wireless radio frequency modem that allows data transmissions to a remotely based controller. The multi-sensor system is equipped for photoionization detection of volatile organic compounds, hydrogen sulfide, carbon monoxide and gamma radiation.

The department also performed air sampling using SUMMA® canisters on Feb. 4 and Feb. 5 to identify possible odor constituents and levels of volatile organic compounds. Cartridges with sampling pumps were used to collect samples that were analyzed for aldehydes. Air samples downwind of the landfill were collected from six locations in the vicinity of the landfill, including locations in a residential area.

The department coordinated with the U.S. Environmental Protection Agency and established additional air sampling locations using EPA's VIPER® communications package with existing department air sampling equipment on Feb. 13. These additional locations will allow the department to further sample air quality in advance of additional corrective action being undertaken by Republic.

On Feb. 15, the department performed air sampling using SUMMA® canisters in response to odors associated with drilling of a new gas extraction well. While drilling the gas extraction well, the drill encountered a pocket of pressurized landfill gas below the ground's surface at about a 100 foot depth. The presence of such a pocket of landfill gas in a landfill experiencing a subsurface smoldering event is not unexpected. In this instance, the drill rig was affected requiring repair that resulted in a short-term increase in the intensity of odors. When Bridgeton/Republic notified the department of the increase in odors, the air sampling was performed. The results of the department's Feb. 15 air sampling are included below.

Air Sampling Results

The Department of Health and Senior Services reviewed the air quality screening data from the Feb. 2 sampling event, including levels of carbon monoxide, total volatile organic compounds and hydrogen sulfide. A review of the air quality data found that gas concentrations did not exceed a level of concern for public health. Department of Health and Senior Services also reviewed the gamma radiation readings detected by the Department of Natural Resources and collected samples from the air to provide additional details. The real time radiation sampling by DNR did not detect gamma radiation rates

outside of normal levels. Laboratory analysis of the Department of Health and Senior Services samples by two different laboratories confirmed that no radioactivity was detected above normal background levels.

The Department of Health and Senior Services reviewed the air sample data from the Feb. 4-5 sampling event, including the concentrations of 62 volatile organic compounds and 12 aldehydes in the air. Department of Health and Senior Services analysis found the analyzed gas concentrations did not exceed a level of concern for public health.

Samples collected in a nearby residential area also showed no chemicals detected above a level of public health concern. Samples were also collected along the landfill property line to capture the worst-case exposure scenario. Department of Health and Senior Services did identify a short-term benzene concentration in one sample near the landfill property line that was slightly above a conservative health-protective screening level for long-term (>1 year) residential exposure. However, this momentary sample result was two to three times less than health-protective screening levels for shorter term exposures. A significant decrease in landfill gas chemical concentrations was observed from the property line to the residential neighborhood, apparently due to dispersion of the landfill gases in ambient air.

On Feb. 15, grab samples were collected from three locations in the vicinity of the Bridgeton Sanitary Landfill during a period of strong odor emissions. This included two downwind locations, one of which was near a residential area approximately 1,500 feet from the landfill. The third sample was collected from an upwind location. DHSS reviewed the air sample data and concentrations of volatile organic compounds (VOCs) in the ambient air samples and found that the analyzed gas concentrations did not exceed a level of concern for public health.

Of the 62 VOCs targeted in the analysis, 12 VOCs were detected in downwind samples. Of the 12 VOCs detected, only benzene in the sample collected near the landfill property line exceeded a health-based screening level for chronic (>1 year) exposure. A lower benzene concentration was detected at the sampling location near the residential area, but did not exceed the screening levels for chronic exposure. None of the detected VOCs exceeded health-based screening levels for acute (<14 days) or intermediate (2 weeks - 1 year) exposure.

The department will continue to share all air sampling results with the Department of Health and Senior Services to evaluate potential public health concerns related to air quality. The Department of Natural Resources' data that has been collected and scientifically validated is posted below. Watch this page for new data as it becomes available.

- Air Sampling Location Map using AreaRAE - Feb. 2. - included
- Air Sampling Report using AreaRAE - Feb. 2. - included
- Air Sampling Location Map using SUMMA® - Feb. 4-5. - included
- Air Sampling Report using SUMMA® - Feb. 4-5
- Air Sampling Location Map using VIPER® - Feb. 13. included
- Air Sampling Location Map using SUMMA®- Feb. 15.
- Air Sampling Report using SUMMA® - Feb. 15.

Previous Bridgeton/Republic Air Sampling

Bridgeton/Republic completed a comprehensive air sampling on Aug. 16 and 17, 2012 with Solid Waste Management Program staff overseeing and evaluating the sampling process. An air sampling report was submitted on Oct. 21, 2012 for Bridgeton/Republic by their contractor. The report characterizes the upwind, downwind and source air to view the report.

- Air Sampling Location Map - Aug. 16-17, 2012. included
- Air Sampling Report - Aug. 16-17, 2012. executive summary & see 5.0 Table 2 included

Bridgeton Sanitary Landfill
February 2, 2013 Sampling Locations

Last Updated 2/21/2013 nrnorrd

Missouri Department of Natural Resources
Division of Environmental Quality
Solid Waste Management Program

0 375 750 1,500 Feet

Although data sets used to create this map have been compiled by the Missouri Department of Natural Resources, no warranty, expressed or implied, is made by the department as to the accuracy of the data and related materials. The act of distribution shall not constitute any such warranty, and no responsibility is assumed by the department in the use of these data or related materials.

Legend

- Leachate Sample
- Air Sample
- Leachate Spill
- Waste Areas (approximate)
- Thermal Event Area (approximate)

Attachment L

2/2/13

Morning Maximums

Unit	Analyte	Max
2	CO	0.7 ppm
	VOC	0.2 ppm
	H_2S	0.0 ppm
6	CO	0.0
	VOC	0.0
	H_2S	0.0
7	CO	1.9
	VOC	6.8
	Gam.	5 uR/hr
10	CO	0.0
	VOC	2.3
	Gam.	8 uR/hr
11	H_2S	0.0
	VOC	4.1
	Gam.	8 uR/hr
12	CO	1.9
	VOC	14.4
	Gam.	31 uR/hr
13	H_2S	0.1
	VOC	0.5
	Gam.	5 uR/hr

Compare Value:

CO 8hr Avg	9 ppm
CO 1hr Avg	35 ppm
H_2S acute	0.07 ppm

* DL = 0.1 ppm

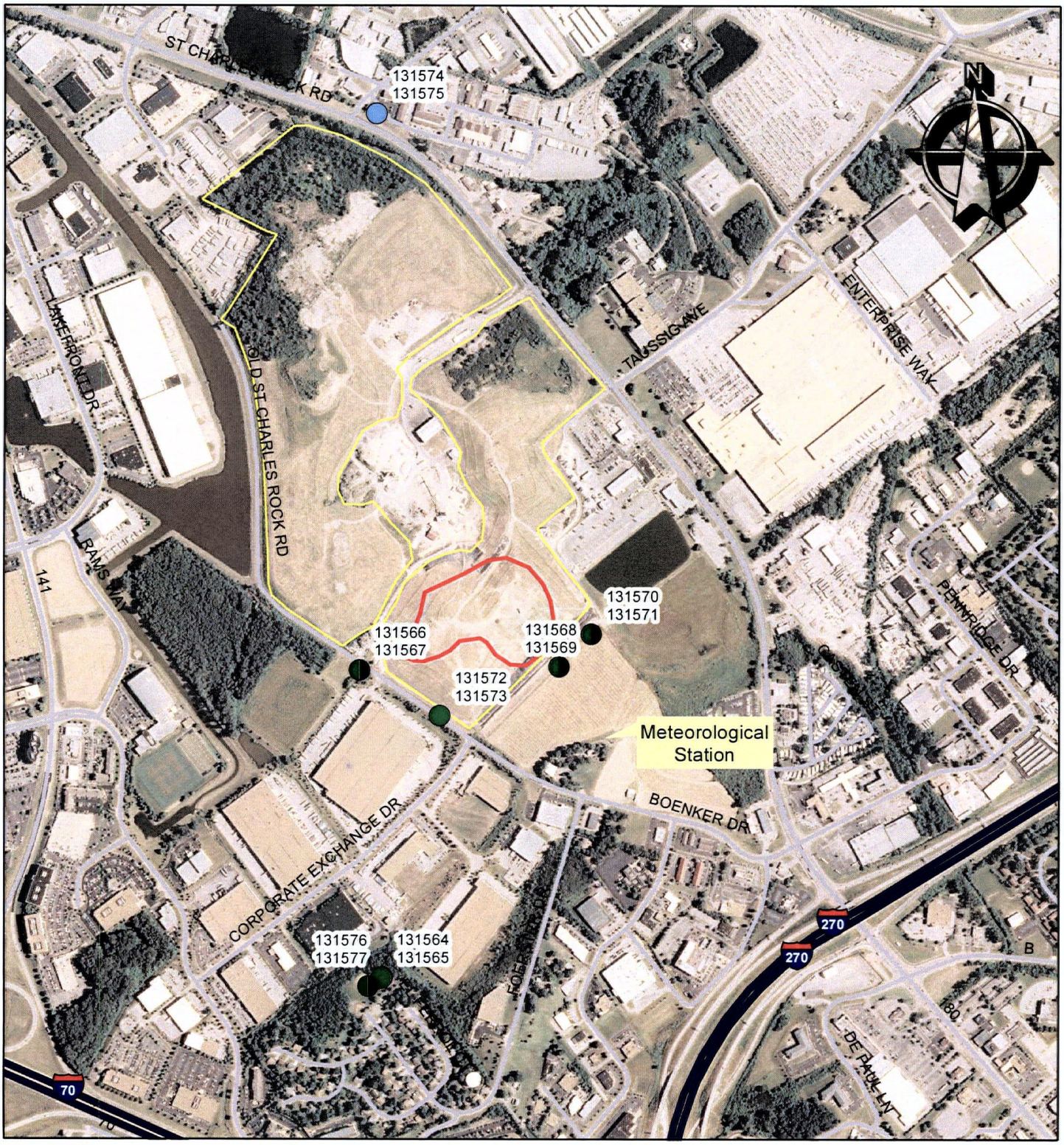
VOC = ? CV

For CO, detections above the 8hr or 1hr max for a sustained time (several minutes, or even hours for the 8hr standard) may be a concern.

For H_2S, any consistent detections (for several minutes to an hour) may be a concern

[redacted]
Staff cell phone number redacted.

Bridgeton Sanitary Landfill
February 4, 2013 Sampling Locations



Last Updated 2/19/2013 nrnorrd

Missouri Department of Natural Resources
Division of Environmental Quality
Solid Waste Management Program

0 375 750 1,500 Feet

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Legend

Type, Duration
- Downwind, 4 Hour
- Downwind, Grab
- Upwind, Grab

- Waste Areas (approximate)
- Thermal Event Area (approximate)

DNR sample ID
VOC sample
Aldehyde sample

Bridgeton Sanitary Landfill
February 2013 VIPER Air Sampling Locations

Last Updated 2/19/2013 nrnorrd

Missouri Department of Natural Resources
Division of Environmental Quality
Solid Waste Management Program

0 375 750 1,500 Feet

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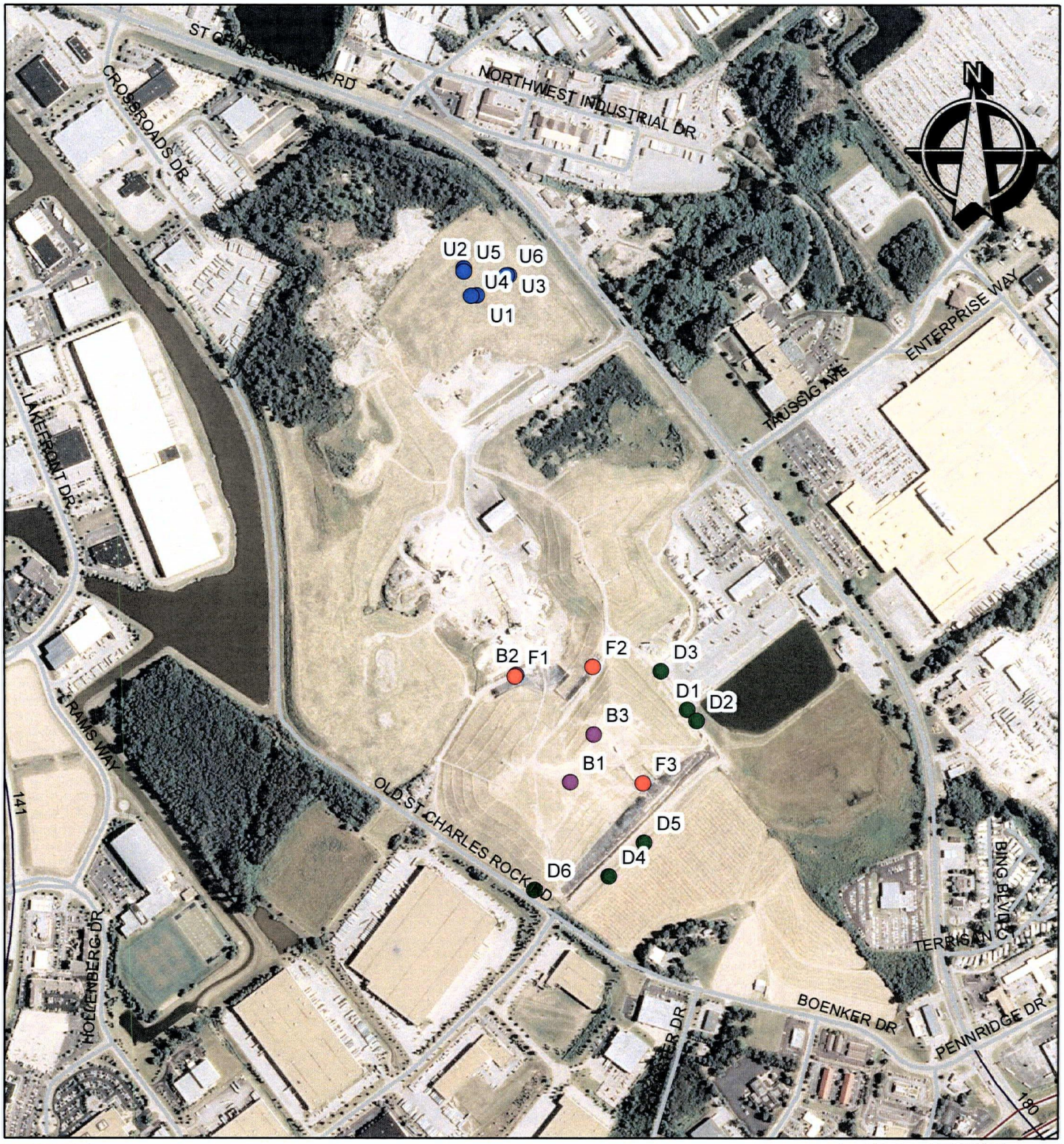
Legend

- Sample Location
- Waste Areas (approximate)
- Thermal Event Area (approximate)

Bridgeton Sanitary Landfill
August 2012 Air and Landfill Gas Sampling



Last Updated 2/19/2013 nrnorrd

Missouri Department of Natural Resources
Division of Environmental Quality
Solid Waste Management Program

0 500 1,000 2,000 Feet

Legend - Sample Type

- On-site Breathing Zone
- Landfill Gas
- Downwind
- Upwind

Executive Summary

On Thursday, August 16 and Friday, August 17, 2012, Stantec Consulting Services Inc (Stantec) conducted an extensive study of airborne and landfill gases and vapors on and around the Bridgeton Landfill, 13570 St Charles Rock Road, Bridgeton, Missouri (the landfill) The study was conducted to determine and document the presence and concentration of a large number of chemical compounds which may be present from landfill decomposition and related biological and chemical phenomena occurring or potentially occurring in the landfill These chemical compounds may potentially contribute to odors reportedly detected by residential, commercial and industrial neighbors of the landfill property, and were also evaluated for their potential contribution to occupational and community health

In advance of the air sampling event, Stantec and Bridgeton Landfill, LLC coordinated with the Missouri Department of Natural Resources (MDNR) to develop a sampling plan to thoroughly characterize the ambient air and landfill gas/vapor, and to answer questions posed by the interested stakeholders and members of the public The final "Air Sampling Work Plan" (the "Work Plan"), approved by MDNR was issued August 14, 2012 and served as the basis for the sampling event

As requested and approved by MDNR in the Work Plan, samples of air and landfill gas were analyzed for the following individual constituents and analytical groupings that are of potential concern for occupational and community health, some of which may contribute to the odor Analytical methods selected and utilized were specified by US EPA, the Occupational Safety and Health Administration (OSHA), the National Institute of Occupational Safety and Health (NIOSH), the American Society for Testing and Materials (ASTM), and methods developed by Columbia Analytical Laboratories (AQL) specifically for odor investigations All methods were presented in the Work Plan and approved by MDNR

- Fixed Gases EPA 3C (hydrogen, oxygen + argon, nitrogen, carbon monoxide, carbon dioxide, methane)
- Ammonia OSHA ID-188
- Mercury and Compounds NIOSH 6009
- Hydrogen Cyanide NIOSH 6010
- Reduced Sulfur Compounds ASTM D5504
- Volatile Organic Compounds and Tentatively Identified Compounds EPA TO-15
- Aldehydes (Carbonyl Compounds) EPA TO-11A
- Amines (Aliphatic) AQL 101

- Carboxylic Acids AQL 102
- Polycyclic Aromatic Hydrocarbons (PAHs) EPA TO-13A
- Polychlorinated Dibenzo-p-Dioxins and Dibenzofurans (Dioxins/Dibenzofurans) EPA TO-9

Samples of gas from under the flexible membrane liner (FML) in the Amphitheater, Second Tier, and East Face were found to contain numerous VOCs and TICs, aldehydes, reduced sulfur compounds, carboxylic acids (none detected in the sample from the second tier), naphthalene and coal-tar pitch volatile PAHs, and PCDD/PCDF The variability in the concentrations of specific compounds found in gas from the three FML locations may help to explain the perceptible differences in odors across the landfill

Samples of ambient air obtained from various locations on or adjacent the landfill were found to have detectable levels of several target compounds present, but at concentrations significantly below those detected under the FML

The analytical results for ambient air were compared to occupational standards promulgated by OSHA and guidelines developed by NIOSH and ACGIH No constituent detected in samples of ambient air from locations on the active areas of the landfill and downwind at the fence line exceeded or even approached applicable occupational standards or guidelines

Analytical results for the ambient air samples were also compared to risk-based US EPA Regional Screening Level (RSL) concentrations for industrial and residential exposure Of the compounds detected in samples of ambient air from locations on the active areas of the landfill and downwind at the fence line, only benzene and formaldehyde were present at concentrations exceeding the respective risk-based US EPA Regional Screening Levels (RSLs) for industrial and residential exposure The RSLs for both of these compounds are very close to the laboratory method reporting limits Formaldehyde was not found in landfill gas and is consistent with ambient background as evidenced by similar concentrations found in the upwind samples Although benzene was not detected in the upwind samples, it is a common constituent in ambient air from urban/industrial areas

The likely contributors to the odor observed at off-site locations are reduced sulfur compounds (e g , dimethyl sulfide and mercaptans) and carboxylic acids (e g , butyric acid and valeric acid) that have extremely low odor thresholds It should be recognized that the odors of many of the reduced sulfur compounds and carboxylic acids are perceptible to the human nose at concentrations that are well below levels that present a health risk

The results of the extensive sampling conducted in August support the conclusion that although some landfill emissions have resulted and may result in a perceptible odor, there were no compounds at concentrations of health concern to members of the surrounding community or to the people working on the landfill

Table 2

Summary of analytical results for all compounds detected under the FML[1]
Bridgeton Landfill

Compounds/analytes	*Concentrations in ug/m³[2]*					
	Amphitheater		*Second Tier*		*East Face*	
	Stantec	*MDNR[3]*	*Stantec*	*MDNR*	*Stantec*	*MDNR*
2-Methyl cyclopentanone	51,000		ND		ND	
Methyl hexanoate	43,000		ND		ND	
2-Ethyl cyclopentanone	41,000		ND		ND	
n-Decane	40,000		ND		ND	
p-Isopropyltoluene	120,000		ND		42,000	
n-Undecane	46,000		ND		ND	
Dimethyl ether	ND		120,000		ND	
Isobutene	ND		140,000		85,000	
n-Butane	ND		41,000		35,000	
C4-H8 Alkene (5 51 RT)	ND		83,000		33,000	
C4-H8 Alkene (5 80 RT)	ND		90,000		34,000	
Isopentene	ND		42,000		ND	
Cyclopentene	ND		41,000		33,000	
C6-H10 Alkene (13 0 RT)	ND		110,000		74,000	
C10-H12 Alkene (14 58 RT)	ND		92,000		71,000	
C10-H12 Alkene (14 63 RT)	ND		110,000		93,000	
3-Methyl-3-heptene	ND		27,000		29,000	
C8-H14 Alkene (16 96 RT)	ND		22,000		ND	
C8-H14 Alkene (16 89 RT)	ND		ND		31,000	
Aldehydes						
Formaldehyde	ND		ND		ND	
Acetaldehyde	1,200		ND		350	
Propionaldehyde	660		ND		140	

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Summary of analytical results for all compounds detected under the FML[1]
Bridgeton Landfill

Compounds/analytes	*Concentrations in µg/m³*[2]					
	Amphitheater		*Second Tier*		*East Face*	
	Stantec	*MDNR*[3]	*Stantec*	*MDNR*	*Stantec*	*MDNR*
Butyraldehyde	3,000		ND		1,500	
Benzaldehyde	2,300		140		990	
Isovaleraldehyde	ND		120		ND	
Valeraldehyde	ND		1,200		ND	
o-Tolualdehyde	ND		340		92	
2,5-Dimethyl-benzaldehyde	720		ND		960	
Reduced Sulfur Compounds						
Hydrogen sulfide	ND		27		ND	
Carbonyl sulfide	ND		150		150	
Methyl mercaptan	490		4,000		260	
Ethyl mercaptan	460		130		17	
Dimethyl sulfide	240,000		600,000		570,000	
Carbon disulfide	190		180		2,300	
Isopropyl mercaptan	210		170		ND	
t-Butyl mercaptan	380		29		ND	
Ethyl methyl sulfide	12,000		4,000		5,100	
Thiophene	11,000		5,000		19,000	
Isobutyl mercaptan	ND		420		ND	
n-Butyl mercaptan	2,100		710		1,400	
Dimethyl disulfide	4,100		20,000		54,000	
3-Methylthiophene	840		330		900	
Tetrahydrothiophene	ND		210		380	
2,5-Dimethylthiophene	ND		ND		800	

Table 2

Summary of analytical results for all compounds detected under the FML[1]
Bridgeton Landfill

Compounds/analytes	*Concentrations in ug/m³[2]*					
	Amphitheater		*Second Tier*		*East Face*	
	Stantec	*MDNR[3]*	*Stantec*	*MDNR*	*Stantec*	*MDNR*
2-Ethylthiophene	ND		ND		840	
Carboxylic Acids						
Acetic Acid	11,000		ND		ND	
Propionic Acid	13,000		ND		9,200	
2-Methylpropionic Acid	12,000		ND		13,000	
Butanoic Acid	56,000		ND		41,000	
3-Methylbutanoic Acid	11,000		ND		9,000	
Pentanoic Acid	23,000		ND		3,800	
3-Methylpentanoic Acid	610		ND		ND	
4-Methylpentanoic Acid	1,100		ND		ND	
Hexanoic Acid	53,000		ND		1,200	
Heptanoic Acid	2,900		ND		ND	
2-Ethylhexanoic Acid	4,800		ND		1,800	
Octanoic Acid	690		ND		ND	
PAHs						
Naphthalene	35		7 9		13	
Acenaphthene	4 5		0 23		0 22	
Fluorene	3 4		0 2		0 18	
Phenanthrene	0 21		0 44		0 19	
Anthracene	0 19		0 022		0 041	
Fluoranthene	ND		0 019		0 026	
Pyrene	ND		0 021		0 016	

Table 2

Summary of analytical results for all compounds detected under the FML[1]
Bridgeton Landfill

Compounds/analytes	Concentrations in µg/m³ [2]					
	Amphitheater		Second Tier		East Face	
	Stantec	MDNR [3]	Stantec	MDNR	Stantec	MDNR
TCDD TEQ	1 52E-08		1 03E-08		3 00E-08	

Footnotes

1) FML - flexible membrane liner covering specific areas of the surface of the landfill
2) $\mu g/m^3$ - micrograms per cubic meter
3) Missouri Department of Natural Resources
4) ND - not detected
5) Refer to Figure 1, Location of Samples, for location descriptions

partial report

5.0 Analytical Results

5.1 LANDFILL GAS FROM UNDER THE FML

included Table 2 presents a summary of the analytical results for all compounds detected in samples of gas from the three locations under the FML

5 1.1 Analytes Not Detected in Any Sample

The following analytes were not detected in any of the gas samples collected from the three locations under the FML carbon monoxide, ammonia, hydrogen cyanide, mercury, and amines Benzo(a)pyrene and the related carcinogenic PAHs associated with incomplete combustion of organic matter were also not found in any of the gas samples

5.1.2 Fixed Gases

The gas from under the FML in the Amphitheater was found to contain oxygen + argon (7 68%), nitrogen (35 7%), methane (9 94%), and carbon dioxide (46 7%) Gas from under the FML on the Second Tier was found to contain hydrogen (1 29%), oxygen + argon (7 92%), nitrogen (47 0%), methane (8 70%), and carbon dioxide (35 0%) Gas from under the FML on the East Face was found to contain hydrogen (2 03%), oxygen + argon (8 04%), nitrogen (47 7%), methane (10 7%), and carbon dioxide (31 4%)

5.1.3 Volatile Organic Compounds

Thirty five (35) target analytes and twenty eight (28) Tentatively Identified Compounds (TICs) were found in at least one of the three samples taken from under the FML As summarized in Table 2, it is apparent that the three FML locations had somewhat different profiles with respect to the specific compounds that were detected and the concentrations of those compounds The following VOCs were found in all three locations propene, tetrahydrofuran, benzene, n-heptane, toluene, n-octane, ethylbenzene, m, p- and o-xylenes, n-nonane, cumene, alpha-pinene, and d-limonene The following TICs were found in all three locations furan, dimethyl sulfide, and 2-methylfuran

5.1 4 Aldehydes

Formaldehyde was not found in any of the samples collected under the FML Acetaldehyde, propionaldehyde, butyraldehyde, o-tolualdehyde, and 2,5-dimethylbenzaldehyde were found in two samples, and isovaleraldehyde, and valeraldehyde were found in one sample

5.1 5 Reduced Sulfur Compounds

Hydrogen sulfide was detected in the sample from under the FML on the Second Tier, and was undetected in the other two "under FML" locations The following reduced sulfur compounds were detected in all three under FML samples dimethyl sulfide, methyl mercaptan, ethyl mercaptan, carbon disulfide, ethyl methyl sulfide, thiophene, dimethyl disulfide, and 3-methyl thiophene The following compounds were detected in one or two of the samples carbonyl sulfide, isopropyl mercaptan, t-butyl mercaptan, isobutyl mercaptan, 3-methyl thiophene, 2,5-

dimethyl thiophene, and 2-ethyl thiophene Dimethyl sulfide and dimethyl disulfide were the reduced sulfur compounds detected at the highest concentrations

5.1.6 Carboxylic Acids

No carboxylic acid compounds were detected in the gas from under the FML on the Second Tier All carboxylic acid target analytes were found in gas from under the FML on the Amphitheater acetic acid, propionic acid, 2-methylpropionic acid, butanoic acid, 2-methylbutanoic acid, pentanoic acid, 3-methylpentanoic acid, 4-methylpentanoic acid, hexanoic acid, heptanoic acid, 2-ethylhexanoic acid, and octanoic acid All of the same analytes were found in gas from under the FML on the East Face except acetic acid, 3-methylpentanoic acid, 4-methylpentanoic acid, and octanoic acid

5.1.7 PAHs

With the exception of fluoranthene and pyrene which were not found in gas from under the FML in the Amphitheater, the following PAHs were found in gas from under the FML in all three locations naphthalene, acenaphthene, fluorine, phenanthrene, anthracene, fluoranthene, and pyrene It is significant to note that benzo(a)pyrene and related carcinogenic PAHs associated with incomplete combustion of organic matter were not found in any of the samples of gas from under the FML

5.1 8 Dioxins/Dibenzofurans

Table 3 presents the concentrations of individual PCDD and PCDF isomers measured in samples of gas from the three locations under the FML Consistent with US EPA guidance, the detected concentrations of the individual dioxin and dibenzofuran isomers were converted to a 2,3,7,8-TCDD Toxicity Equivalent Concentration (TEQ) using the Toxicity Equivalence Factors (TEFs) recommended by US EPA (December 2010) The TCDD TEQ concentrations for the individual isomers were added to yield a single TCDD TEQ concentration for the sample The TCDD TEQs for gas from each of the under FML samples were Amphitheater (1 28E-08 $\mu g/m^3$), Second Tier (1 03E-08 $\mu g/m^3$), and East Face (3 00E-08 $\mu g/m^3$)

5.2 AMBIENT AIR FROM LOCATIONS ON THE LANDFILL AND DOWNWIND AT THE FENCE LINE

As described in Section 4, (shown on Figure 1), ambient air samples were collected from three locations within the active remediation area on the landfill where a strong odor was evident These three locations are designated as the Amphitheater, the Summit and the Summit Valley Samples were collected at six locations along the fence line that were downwind of the active areas of the landfill and where the odor was present at the time the samples were taken Table 4 presents a summary of the analytical results for locations on the landfill and downwind at the fence line

5.2 1 Analytes Not Detected in Any Sample

The following analytes were not detected in any samples of air from locations on the landfill or downwind at the fence line ammonia, hydrogen cyanide, mercury, amines, carboxylic acids,

and reduced sulfur compounds with the exception of dimethyl sulfide Benzo(a)pyrene and the related carcinogenic PAHs associated with incomplete combustion of organic matter were also not found in any of the air samples from locations on the landfill and downwind at the fence line

5 2.2 Fixed Gases

The sample bags for the Pond East and Pond West locations were deflated when they arrived at the analytical laboratory and consequently there are no results for these two locations For all of the other locations on the landfill where samples for fixed gases were collected, the percentage of oxygen + argon was 21 5% and the percentage of nitrogen was 78 4 to 78 5% Hydrogen, carbon monoxide, methane and carbon dioxide were not detected in measurable concentrations

5.2.3 Volatile Organic Compounds

Twenty (20) Target Analyte VOCs and sixteen (16) TICs were found in low $\mu g/m^3$ concentrations in one or more of the downwind locations on the landfill The Target Analytes detected were propene, dichlorodifluoromethane, ethanol, acetonitrile, acetone, trichlorofluoromethane, methylene chloride, 2-butanone (methyl ethyl ketone), ethyl acetate, tetrahydrofuran, benzene, toluene, n-octane, tetrachloroethene, ethylbenzene, m,p-xylenes, o-xylene, n-nonane, alpha-pinene and d-limonene The TICs were furan, dimethyl sulfide, methyl acetate, 2-methylfuran, methylpropionate, ethylpropionate, methylbutyrate, ethyl butyrate, isobutene, hexamethylcyclotrisiloxane, 2-ethyl-1-hexanol, acetic acid, 2-butoxyethanol, isopentane and a C6-H10 alkene No VOC or TIC was found at concentrations exceeding occupational exposure standards Only benzene was present at concentrations exceeding the very conservative US EPA risk-based RSLs for residential and industrial exposure Table 4 presents the concentrations of VOCs and TICs detected in air samples from the six downwind locations and on the landfill US EPA RSLs, OSHA PELs, and ACGIH TLVs are presented for comparison

It should be noted that two SUMMA™ canisters were collected from the South Fence line location because the first canister South Fence #1 lost vacuum within the first hour and was considered potentially unreliable A second canister, designated as South Fence #2 was activated and collected air for a duration of 4 hours The analytical results from both canisters are presented in Table 4

5 2.4 Aldehydes

Acetaldehyde was detected in all of the samples, and was the only aldehyde detected in air samples from the Amphitheater and East Fence line locations 1 & 2 As shown on the tables, acetaldehyde was detected in the landfill and downwind samples at concentrations similar to those found in upwind samples Acetaldehyde, formaldehyde, valeraldehyde and 2,5-dimethylbenzaldehyde were found in a number of locations at concentrations similar to those detected in the upwind samples (except valeraldehyde which was not found in the upwind samples)

5.2 5 Reduced Sulfur Compounds

Dimethyl sulfide was the only reduced sulfur compound found in air from locations on the landfill and downwind along the fence line As noted in the discussion of fixed gases (Section 5 2 2), the sample bags for the Pond East and Pond West locations were deflated when they arrived at the analytical laboratory and consequently there are no results for these two locations

5 2.6 PAHs

High volume samples for determination of PAHs were taken from the Summit and the downwind location designated as East Fence #1 The following PAH compounds were detected in these samples naphthalene, acenaphthene, fluorine, phenanthrene, and pyrene (summit only) Benzo(a)pyrene and other related carcinogenic PAHs were not detected in any sample

5.2.7 Dioxins/Dibenzofurans

High volume samples for determination of dioxins/dibenzofurans were also collected from the Summit and East Fence #1 Table 5 shows the concentrations of the individual polychlorinated dibenzo-p-dioxins and dibenzofuran (dioxins/dibenzofurans) isomers that were detected Concsitent with the US EPA guidance, the detected concentrations of the individual dioxins and dibenzofuran isomers were converted to 2, 3, 7, 8-TCDD TEQs The total TCDD TEQ calculated for dioxins in the sample collected at the summit was 1 49E-08 µg/m^3, and the total TCDD TEQ calculated for dioxins in the sample collected at the east fence #1 was 7 88E-09 µg/m^3

5.3 AMBIENT AIR FROM UPWIND/BACKGROUND LOCATIONS

As described previously, background samples were collected from three specific locations in an area on the northwestern portion of the landfill property referred to as the Grassy Knoll This area was upwind of the active remediation areas of the landfill on both August 16 and 17, and no discernible odor was present Samples were collected for all analytical suites except for PAHs One of the high-volume sampling units arrived from the vendor in a non-functional condition and could not be repaired until the next day when repair parts were received Given the aggressive schedule for collecting samples and the desirable 24-hour collection time required for both the PAH and Dioxin/Dibenzofuran analytical methods, it was decided to sacrifice the PAH analysis of background air Table 6 presents a summary of analytical results for all compounds detected in at least one upwind/background sample

5.3.1 Analytes Not Detected in Any Sample

The following analytes were not detected in any of the samples collected from the upwind locations on the Grassy Knoll ammonia, hydrogen cyanide, mercury, amines, carboxylic acids, and reduced sulfur compounds

5.3.2 Fixed Gases

The sample bag from the Grassy Knoll Center collected on August 16, 2012 was deflated upon arrival at the laboratory, thus the sample was not valid All other sample bags arrived intact and

were analyzed Hydrogen, carbon monoxide and methane were not detected in any of the upwind samples A low concentration of carbon dioxide was reported in the August 17, 2012 sample from the Grassy Knoll West The percentage of oxygen + argon was 21 5% in all samples, and the percentage of nitrogen was 78 4 to 78 5%

5.3.3 Volatile Organic Compounds

Seven (7) Target Analyte VOCs were detected in one or more of the upwind samples acetone, acetonitrile, dichlorodifluoromethane, ethyl acetate, tetrachloroethene, trichlorofluoromethane, and toluene Six (6) TICs were detected in one or more of the upwind samples acetic acid, ethyl butyrate, ethyl propionate, hexamethycyclotrisiloxane, and an unidentified compound with retention time of 9 41 minutes The concentrations of all VOCs and TICs are presented by location along with corresponding US EPA RSL and occupational standard/guideline concentrations All reported concentrations of VOCs were below US EPA RSL concentrations for both residential and industrial air

5.3 4 Aldehydes

Three common aldehyde compounds were reported at low µg/m^3 concentrations in one or more of the upwind samples acetaldehyde, formaldehyde, and 2, 5-dimethylbenzaldehyde Both acetaldehyde and formaldehyde were reported at concentrations higher than the US EPA RSL concentrations for residential and industrial air As will be further discussed in section 6 2 2, the conservative risk-based RSLs are very close to, and in some cases less than, standard laboratory method reporting limits Consequently, it is common for detected concentrations of these two compounds to exceed screening levels

5.3 5 Dioxins/Dibenzofurans

One high-volume sample was collected from the Grassy Knoll Center to characterize upwind/background concentrations of the polychlorinated dioxins and dibenzofurans Consistent with US EPA guidance, the concentrations of the individual dioxin and dibenzofuran isomers were converted to 2,3,7,8-TCDD TEQs and evaluated as a single concentration of the index compound As can be seen from Table 7, a number of Dioxin and Dibenzofuran isomers were found to be present at extremely low concentrations in the upwind sample The TCDD TEQ concentration of 1 94E-08 µg/m^3 was consistent with the US EPA RSL for residential air (6 4E-08 µg/m^3) and less than the RSL for industrial air (3 2E-07 µg/m^3)

6.0 Discussion of Sampling Results

6.1 COMPARISON OF COMPOUNDS DETECTED BY LOCATION

6.1.1 Downwind on Landfill Compared to Gas from Under FML

The following compounds were detected in the gas samples from under the FML and the ambient air from locations on the landfill and at the downwind fence line locations, but not in the upwind samples propene, ethanol, 2-butanone (MEK), tetrahydrofuran, benzene, n-octane, ethylbenzene, xylenes, n-nonane, alpha-pinene, d-limonene, furan, dimethyl sulfide, methyl acetate, 2-methyl furan, methyl propionate, methyl butyrate, isobutene, C7-H12 alkene, ethyl propionate, and isopentane

6 1.2 Downwind on Landfill Compared to Upwind/Background

The compounds that were detected in both upwind air and landfill/downwind fence line locations were dichlorodifluoromethane, acetonitrile, acetone, trichlorofluoromethane, ethyl acetate, toluene, tetrachloroethene, acetaldehyde and formaldehyde The concentrations of each detected compound were similar among all samples The two chlorofluorocarbon compounds (Freons), tetrachloroethene, acetaldehyde, and formaldehyde appear to be constituents in the regional air mass moving across the landfill during the times that the samples were collected

6.2 APPLICABLE OCCUPATIONAL AND PUBLIC HEALTH STANDARDS

6.2.1 Occupational Exposure Standards

Occupational Exposure Limits (OELs) published as OSHA PELs (Permissible Exposure Limits) and ACGIH TLVs (Threshold Limit Values) are presented on Tables 4 and 6 for all constituents for which occupational exposure standards or guidelines were available In a few instances where OSHA PELs and ACGIH TLVs have not been developed, AIHA Workplace Environmental Exposure Levels (WEEL) were applied Note that gas from under the FML is not an exposure environment, thus no comparison is made to occupational or risk-based concentrations

ACGIH TLVs are health-based values, and refer to concentrations of chemical substances and represent conditions under which it is believed nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects OSHA PELs are based on 1969 TLVs with the exception that some have been updated as substance specific standards to reflect more current toxicological data and research AIHA WEELs are also similar to TVLs and have been developed for compounds for which there are no TLVs or PELs but for which AIHA believes there is significant potential workplace exposure

The concentrations of all detected compounds in ambient air on the landfill, downwind at the fence line and upwind were low, well below occupational exposure limits In fact, no constituent detected in samples of ambient air from locations on the active areas of the landfill and downwind at the fence line exceeded or even approached applicable occupational standards or guidelines The highest concentration of compounds compared to their respective OELs were benzene in the Pond West sample, dimethyl sulfide in the Summit Valley sample, and

formaldehyde in the Pond Center, Pond East, Pond West, and Summit samples These compounds were detected in concentrations less than 2% of their OEL Most detected sample concentrations were below 0 01% of their OELs

As a special case, a unique TLV for VOCs that may cause similar toxicological effects was developed It is an additive TLV based on the sum of all of the detected concentrations divided by its respective TVL, this sum is compared to one (1) The highest VOC mixture exposure was 1% of the mixture TLV, in the Pond West sample This is well below the mixture TLV even with a 20% addition to account for detected compounds that may cause similar toxicological effects as the other detected VOCs, but that have no OELs

It is clear that detected concentrations of the significant number and variety of compounds collected in ambient air samples on and around the landfill are well below applicable occupational exposure limits In addition, concentrations and exposures to mixtures of the detected volatile organic compounds (presumed additive synergist relationship) are well below the mixture TLV Total adjusted concentrations of dioxin and furan compounds are also well below the OEL and RSLs

6 2 2 Risk-Based Screening Levels

US EPA risk-based Regional Screening Level (RSL) concentrations for exposure to constituents in air in residential and industrial settings are presented on Tables 4 and 6 RSLs for carcinogenic chemicals are derived to correspond to an excess lifetime cancer risk of 1 in 1,000,000 (1 in 1 million or 1E-06) for a person (receptor) who is assumed to be exposed to that concentration on an ongoing basis over an extended period of time (25 years for industrial and 30 years for residential) RSLs for chemicals that produce adverse non-cancer effects are concentrations that are very unlikely to produce health effects in people who are exposed over many years Concentrations of constituents below applicable RSL concentrations are generally not considered to be of concern for public health Concentrations above RSLs do not necessarily mean that adverse health effects will occur, but do indicate that additional evaluation may be appropriate

The vast majority of detections were much lower than the RSL concentrations However, the concentrations of benzene found in air from all three of the downwind fence line locations along the Pond, East Fence line #1, and South Fence line #1 and 2, and on the landfill at the Amphitheater and Summit Valley locations were higher than the conservative RSL for residential exposure (0 31 $\mu g/m^3$), with detected concentrations ranging from 1 5 up to 16 $\mu g/m^3$ The highest concentrations of benzene were found in the three Pond West, Pond Center and Pond east samples Benzene was not detected in the air at the Summit or at the downwind East Fence line #2 location The concentrations of benzene found in the air on the Amphitheater (1 1 $\mu g/m^3$) and the downwind East Fence line #1 location (1 5 $\mu g/m^3$) were similar to the RSL for industrial exposure (1 6 $\mu g/m^3$) It is not uncommon to find concentrations of benzene exceeding the conservative RSLs in air samples in urban/industrial settings

All concentrations of formaldehyde found in upwind locations and in samples from locations on the landfill and the downwind fence line locations were greater than the RSL concentrations, as were the majority of the acetaldehyde concentrations, As indicated previously, the residential and industrial RSLs for formaldehyde (0 19 and 0 94 µg/m^3) and acetaldehyde (1 1 and 5 6 µg/m^3) µg/m^3), are close to the laboratory MRLs for these compounds in ambient air (0 32 – 0 70 µg/m^3) Acetaldehyde and formaldehyde have a number of common sources such as motor vehicle emissions and are frequently found in ambient air in urban settings

6.3 ODOR THRESHOLDS

Table 8 presents the lowest published odor threshold for constituents found in gas from under the FML in comparison to the range of concentrations found in ambient air from locations on the landfill and downwind at the fence line The odor threshold concentrations were obtained from US EPA (1992), Ruth (1986), and AIHA (1997) The characterization of the odor for each individual compound is the description used in the source reference for the odor concentration The range of concentrations at which people can begin to recognize the distinctive odor of a chemical are frequently associated with occupational environments For the majority of chemicals, most people can recognize a characteristic odor at concentrations well below concentrations that are of concern for health The odor descriptions for the individual compounds are not intended to describe the odor associated with Bridgeton Landfill

As indicated on Table 8, the lowest published odor threshold is near or below the laboratory Method Reporting Limits for the ambient air samples for the following compounds present in gas from under the FML ethyl acetate, acetaldehyde, hydrogen sulfide, dimethyl sulfide, dimethyl disulfide, methyl mercaptan, ethyl mercaptan, isopropyl mercaptan, t-butyl mercaptan, isobutyl mercaptan, n-butyl mercaptan, thiophene, butanoic (butyric) acid, and pentanoic (valeric) acid

The reduced sulfur compounds as a group have odors that are commonly described as "rotten eggs", "decayed cabbage", "sulfide-like", and "disagreeable" Mercaptans can be perceived at such low concentrations that they are added to natural gas as odorants to warn of gas-leaks

As mentioned previously, the majority of the Tedlar™ bags for the ambient samples were deflated upon arrival at the analytical laboratory, although they were intact when shipped from the landfill office Consequently, there is little data for reduced sulfur compounds Dimethyl sulfide was the only sulfur compound detected in the usable ambient air samples from locations on the landfill Dimethyl sulfide and dimethyl disulfide were the two sulfur compounds found at the highest concentrations in the samples of gas from under the FML Because the odor thresholds for many of the reduced sulfur compounds are below laboratory MRLs, it is not unreasonable to assume that other reduced sulfur compounds found in gas samples from under the FML may also be present in ambient air It is very likely that reduced sulfur compounds were significant contributors to the odor

The carboxylic acids as a group have odors that are commonly described as "sour", "perspiration", "body odor", and "cheesy" A number of carboxylic acids were found in gas from under the FML from the amphitheater and the east face, but not the second tier, with the

Table 2

Summary of analytical results for all compounds detected under the FML[1]
Bridgeton Landfill

Compounds/analytes	*Concentrations in µg/m³[2]*					
	Amphitheater		*Second Tier*		*East Face*	
	Stantec	*MDNR[3]*	*Stantec*	*MDNR*	*Stantec*	*MDNR*
Volatile Organic Compounds						
Propene	27,000	22,546	95,000	168,919	37,000	74,332
Chloromethane	ND[4]		ND		2,700	
1,3-Butadiene	590		ND		ND	
Chloroethane	ND		5600		ND	
Ethanol	99,000		ND		ND	
Acetone	500,000	672,255	ND	91,455	72,000	124,712
2-Propanol	60,000		ND		ND	
2-Butanone (MEK)	340,000		ND		89,000	
Ethyl acetate	4,800		ND		ND	
n-Hexane	2,100		ND		2,900	
Tetrahydrofuran	170,000	180,816	39,000	ND	70,000	62,828
Benzene	120,000	130,663	620,000	837,007	390,000	450,450
Cyclohexane	1,100		ND		ND	
1,4-Dioxane	4,100		ND		ND	
n-Heptane	3,200		8,000		3,300	
4-methyl-2-pentanone	30,000	20,565	ND	ND	16,000	16,181
Toluene	43,000	44,845	100,000	128,129	48,000	73,109
2-Hexanone	11,000		ND		3,100	
n-Butyl acetate	12,000		ND		ND	
n-Octane	9,500		17,000		13,000	
Chlorobenzene	3,000		ND		ND	
Ethylbenzene	27,000	38,700	32,000	42,942	22,000	29,699

Table 2

Summary of analytical results for all compounds detected under the FML[1]
Bridgeton Landfill

Compounds/analytes	*Concentrations in µg/m³*[2]					
	Amphitheater		*Second Tier*		*East Face*	
	Stantec	*MDNR*[3]	*Stantec*	*MDNR*	*Stantec*	*MDNR*
m,p-Xylenes	57,000	39,511	37,000	31,566	40,000	34,475
0-Xylene	20,000	13,460	12,000	18,106	16,000	24,836
Styrene	1,200		ND		ND	
n-Nonane	16,000		17,000		9,000	
Cumene	6,000		5,200		4,300	
Alpha-Pinene	12,000		53,000		16,000	
n-Propylbenzene	3,800		ND		2,200	
4-Ethyltoluene	4,900		ND		2,900	
1,3,5-Trimethylbenzene	6,700		ND		3,500	
1,2,4-Trimethylbenzene	19,000	23,989	ND	ND	8,300	19,466
1,4-Dichlorobenzene	10,000		ND		3,200	
d-Limonene	22,000		22,000		21,000	
Naphthalene	510		ND		ND	
Tentatively Identified Compounds						
Furan	46,000		120,000		300,000	
Dimethyl sulfide	68,000		83,000		280,000	
Methyl acetate	44,000		ND		ND	
2-Methylfuran	68,000		380,000		240,000	
Methyl propionate	45,000		ND		ND	
1-Butanol	73,000		ND		ND	
2-Pentanone	59,000		ND		ND	
Methyl butyrate	110,000		ND		ND	
Dimethyl disulfide	70,000		ND		42,000	